Docket No.: TAW-008RCE
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Katsunari Oikawa *et al.*

Application No.: 10/804244

Confirmation No.: 7471

Filed: March 18, 2004

Art Unit: 1742

For: SHAPE MEMORY ALLOY AND METHOD FOR PRODUCING SAME

Examiner: G. P. Wyszomierski

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF KATSUNARI OIKAWA UNDER 37 CFR §1.132

Dear Sir:

I, Katsunari Oikawa, a citizen of Japan, hereby declare as follows:

1. I am presently an Associate Professor in the Department of Metallurgy at the Graduate School of Engineering, Tohuku University in Sendai, Japan. I have extensive research experience in the area of materials science as described in the document attached as Exhibit A.

2. I am a co-author of the Applied Physics Letters article "Promising Ferromagnetic Ni-Co-Al Shape Memory Alloy System," (K. Oikawa *et al.*, Applied Physics Letters 79, 3290-3292 (2001)).

3. I am a co-inventor of the claimed subject matter of U.S. Application No, 10/804244 ("the present application"), filed March, 18, 2004, which is referenced above.

4. After reviewing the Office Action issued on April 12, 2007 and the cited references, I understand that claims 1-4 and 9-11 of the present application have been rejected by the Examiner under 35 U.S.C. §103 (a) as being unpatentable over the Applied Physics Letters article "Promising Ferromagnetic Ni-Co-Al Shape Memory Alloy System," (K. Oikawa *et al.*, Applied Physics Letters 79, 3290-3292) (hereinafter the Oikawa APL reference) or over the

abstract of the Japanese patent application publication number JP 2002-129273 (hereinafter the JP'273 reference).

5. The claims of the present application relate to a shape memory alloy comprising Co, Ni and Al. The shape memory alloy contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co with the balance being 28 to 38 atomic % of Ni and inevitable impurities. The shape memory alloy has a two-phase structure comprising a β-phase having a B2 structure and a γ-phase having an fcc structure. At least 40% by area of crystal grain boundaries of the β-phase are occupied by the γ-phase in the shape memory alloy. It is further my understanding that amended claims will claim a shape memory alloy with a fraction of the γ –phase volume being 5 to 50% by volume, and having a tensile strength of 400-1100MPa and a shape recovery of 18% or more.

The Oikawa APL reference describes measurements that were conducted by my research group on 150 micron thick specimens of an alloy with the composition $Co_{40}Ni_{33}Al_{27}$ having two phases (β+γ), with about 7 vol % of the alloy having the γ-phase (page 3292, column 1). The aforementioned alloy will be referred to as "comparative example 2." As described in the reference, the comparative example 2 specimens were heat treated at 1623K (1350°C) for two minutes (0.035 hours) and heat treated at 1573K (1300°C) for 15 minutes (0.25 hours), (page 3292, column 1).

Additional experiments were performed on the comparative example 2 specimens that determined properties of the comparative example 2 alloy which were not included in the published Oikawa APL reference. Additional experimentally determined properties of the comparative example 2 alloy are listed below and appear in Table 1. The ratio by area of crystal grain boundaries of the β-phase being occupied by the γ-phase (γ-phase area ratio) was experimentally determined to be 32 % for the comparative example 2 alloy. The tensile strength of the comparative example 2 alloy was experimentally determined to be 260 MPa.

Table 1 presents published and unpublished properties of the comparative example 2 alloy that were experimentally determined by my research group. The unpublished data is indicated by bold font and underlining.

Table 1

	Composition (atomic %)			γ-Phase Volume Fraction (%)	γ-Phase Area Ratio (%)	Heat Treatment (°C/hour)	Shape Recovery Ratio (%)	Tensile Strength (MPa)
	Al	Co	Ni*					
Comparative Example 2 (APL article)	27	40	33	7	**<u>32</u>**	1350/0.035. + 1300/0.25	83	**<u>260</u>**
Example 10 (specification p. 21-22)	26	41	33	22	60	1350/0.5 + 1300/1	60	750

* Ni and inevitable impurities

The comparative example 2 alloy described in the Oikawa APL reference does not have the γ-phase area ratio required by the present claims. As shown in Table 1, the γ-phase area ratio of the comparative example 2 alloy was experimentally determined to be 32 %, which is not at least 40% as specified by the present claims.

The comparative example 2 alloy does not exhibit a recovery ratio of at least 18% and a high tensile strength of 400-1100MPa as required by the amended claims. The comparative example 2 alloy described in the Oikawa APL reference, which has a γ-phase area ratio of 32%, exhibits a high recovery ratio 83%, but a low tensile strength of 260MPa. In contrast, the presently claimed alloys, which have a γ-phase area ratio of at least 40%, exhibit an unexpected and desirable combination of a high shape recovery ratio and a high tensile strength. Properties of the example 10 alloy described in the pending application are included in table 1 above for illustrative purposes. The example 10 alloy has a structure with a γ-phase area ratio of 60% and exhibits a combination of a high shape recovery ratio of 60% and a high tensile strength of 750 MPa. The correlation between a high γ-phase area ratio and a combination of a high shape recovery ratio and high tensile strength is further illustrated by the example alloys 1-14 described in the specification and whose properties appear in the tables on pages 21 and 22. The Oikawa APL article does not teach or suggest a correlation between a γ-phase area ratio of over

40% and a combination of a high tensile strength and a high shape recovery ratio as described in the pending patent application.

The γ-phase area ratio is very sensitive to heat treatment, as is demonstrated by a comparison between comparative example 2 of the APL reference, and example 10 of the present application. Although comparative example 2 and example 10 have similar atomic compositions which both fall within the range of atomic compositions recited in claim 1, the differences in the details of the heat treatment, result in a 28% higher γ-phase area ratio for the example 10 alloy of the pending application than for the comparative example 2 alloy of the Oikawa APL reference. The differences in the details of the heat treatment also resulted in a combination of a high tensile strength of 750 MPa and a high shape recovery ratio of 60% for the example 10 alloy of the pending application, as opposed to a combination of a low tensile strength of 260 MPa and a high shape recovery ratio of 83% for the comparative sample 2 alloy of the Oikawa APL reference.

The abstract of the JP '273 reference recites alloys with a broad compositional range; however, the sample alloys presented in the JP '273 reference do not have compositions near the range of compositions recited by the current claims. Although the JP '273 abstract recites alloys that fall in a broad compositional range of 5 to 70 atomic % Co, 5 to 70 atomic % Ni, and 5 to 50 atomic % Al, none of the sample alloys presented in the table on page 1 has a composition in the range of 23 to 27 atomic % Al. Of the samples presented in the table on page 7 of the JP '273 reference, one sample has 9 atomic % Al and the other samples have between 38 and 61 atomic % Al (these numbers were converted from the mass % of the table into atomic %). The compositions of the samples whose properties are described in the JP'273 reference all fall far from the claimed range of 23 to 27% atomic % Al.

Further, the JP'273 reference does not disclose or suggest an alloy with a γ-phase area ratio of at least 40%, or an alloy with a combination of a high tensile strength of 400-1100 MPa and a high shape recovery ratio of at least 18%. The abstract and table 1 of the JP '273 reference are silent regarding the γ-phase area ratio, the tensile strength, and the shape recovery ratio of the described alloys.

6. It is my opinion that the shape memory alloys described in claims 1-4 and 9-11 of the present application are unobvious in view of the Oikawa APL reference and in view of the JP'273 reference. Alloys of the proposed amended claims exhibit an unexpected and surprising

combination of high shape recovery ratio and high tensile strength compared to the alloys described in the Oikawa APL reference.

7. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made may be punishable by fine or imprisonment, or both, and that such willful false statements may jeopardize the validity of this Application for Patent or any patent issuing thereon.

Dated: 9th Oct./2007 Signature: K. Oikawa.